

HP and Itanium 2

Still in the Sandbox



Karen C. Brooks, pSeries Competitive Marketing
June, 2003

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The purpose of this presentation today

HP is about to announce a new server product family, including Superdome, based on Intel's Madison chip...

- ... They are going to say to your customers it is faster, better, and cheaper than IBM pSeries**
- ... They are going to say it can run UNIX (HP-UX), Linux, and Windows 2003 on the same server**
- ... They are going to say it is no big deal to migrate to Itanium**
- ... They are going to say that many ISVs are already there**
- ... They are going to say it represents the future, but they have it today**

What are you going to say when your customers ask you...

What HP is really announcing and what it means

How does it compare to IBM pSeries

What are the truths about Itanium that HP does not want customers to know

How can you refute HP's claims, and what are the selling points to win with IBM pSeries

What steps should you take now and where can you get your questions answered later

Agenda

- Background on Itanium leading to HP's Madison Announcement
- IPF in High Performance Computing
- IPF in Commercial Computing - no traction yet
- Additional marketing collateral

Deja Vu All Over Again?

Intel tried once before (unsuccessfully) to take over the supercomputing market with their i860 processor.

- Intel developed servers with i860 RISC processor
 - ▶ Introduced in products in 1989 and shipped in products through the early 1990's
 - ▶ Introduced Paragon servers with i860 positioned in the large scale computing market
- Other vendors also sold servers/workstations with the i860
 - ▶ Stratus (XA/R introduced in 1992)
 - ▶ Aliant Computer Systems (FX 800, FX 2800, Campus 800)
 - ▶ Okidata Microsystems workstations (Okistation 7300)
- Unsuccessful and Intel withdrew the processor and their servers
 - ▶ Total units shipped with the i860 processor = 886 from 1989-1995 (vs. total market of ~ 700,000/year at that time)
 - ▶ Total units shipped of Intel Paragon servers (large scale market) was 120 from 1989-1995 (vs. total market of ~ 5300/yr for this type large scale server at that time)

Business lesson learned: Intel has a history of abandoning a processor

Source: i860 data from IDC Analyst, Dec, 10, 2002

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HP and Intel Co-Develop Itanium

- Approximately early to mid-1990's
- Almost 10 years and billions of dollars later and still behind
- HP has staked the future of the company on the success of Itanium
 - ▶ would be extremely difficult to refocus their server line if Itanium fails to take off as promised

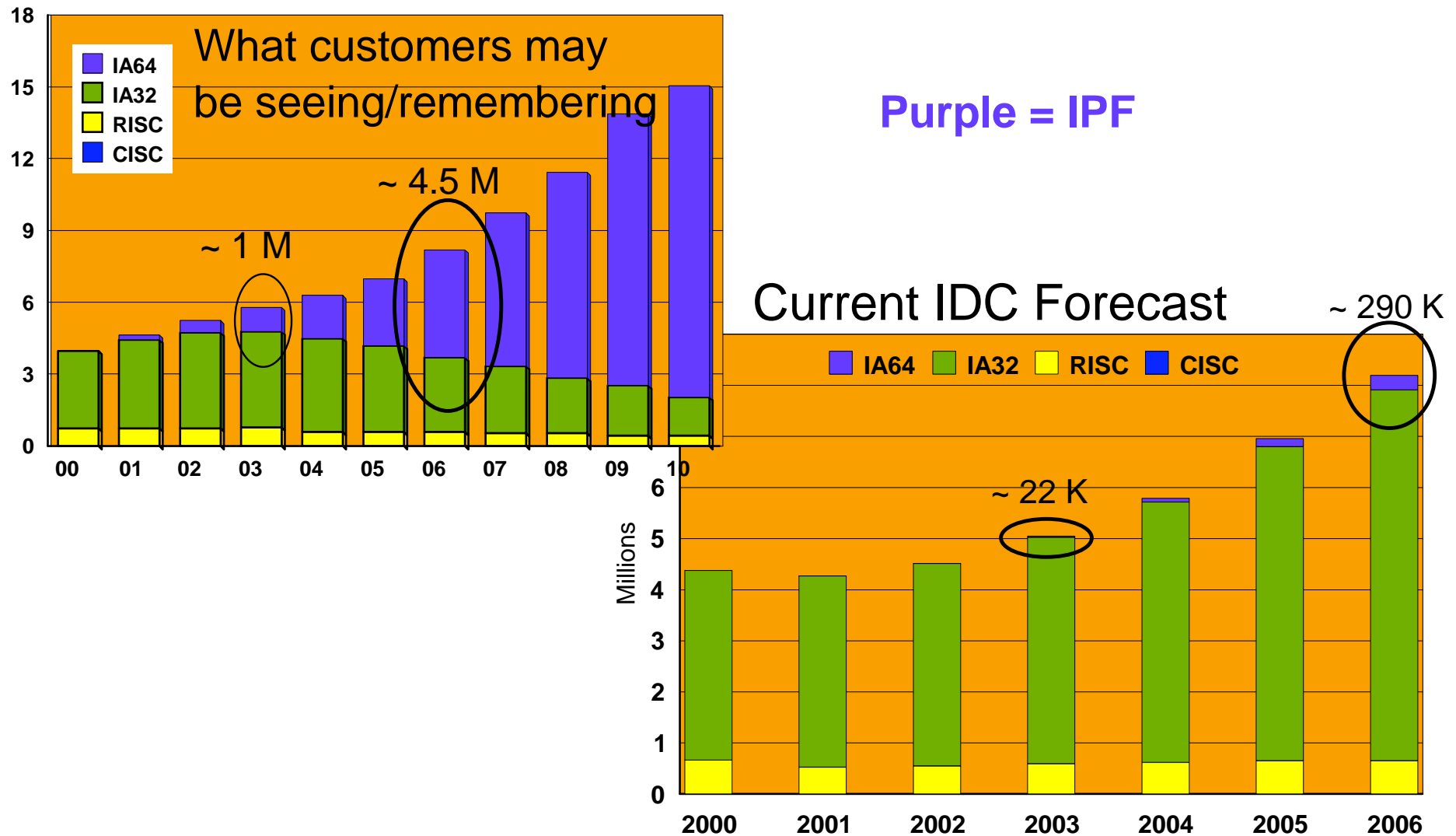
Source: i860 data from IDC Analyst, Dec, 10, 2002

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IDC's WW Server Unit Shipments Forecast by Chip: 2001-2006



Source: IDC, WW Server Market Forecast, Update, 2001-2006

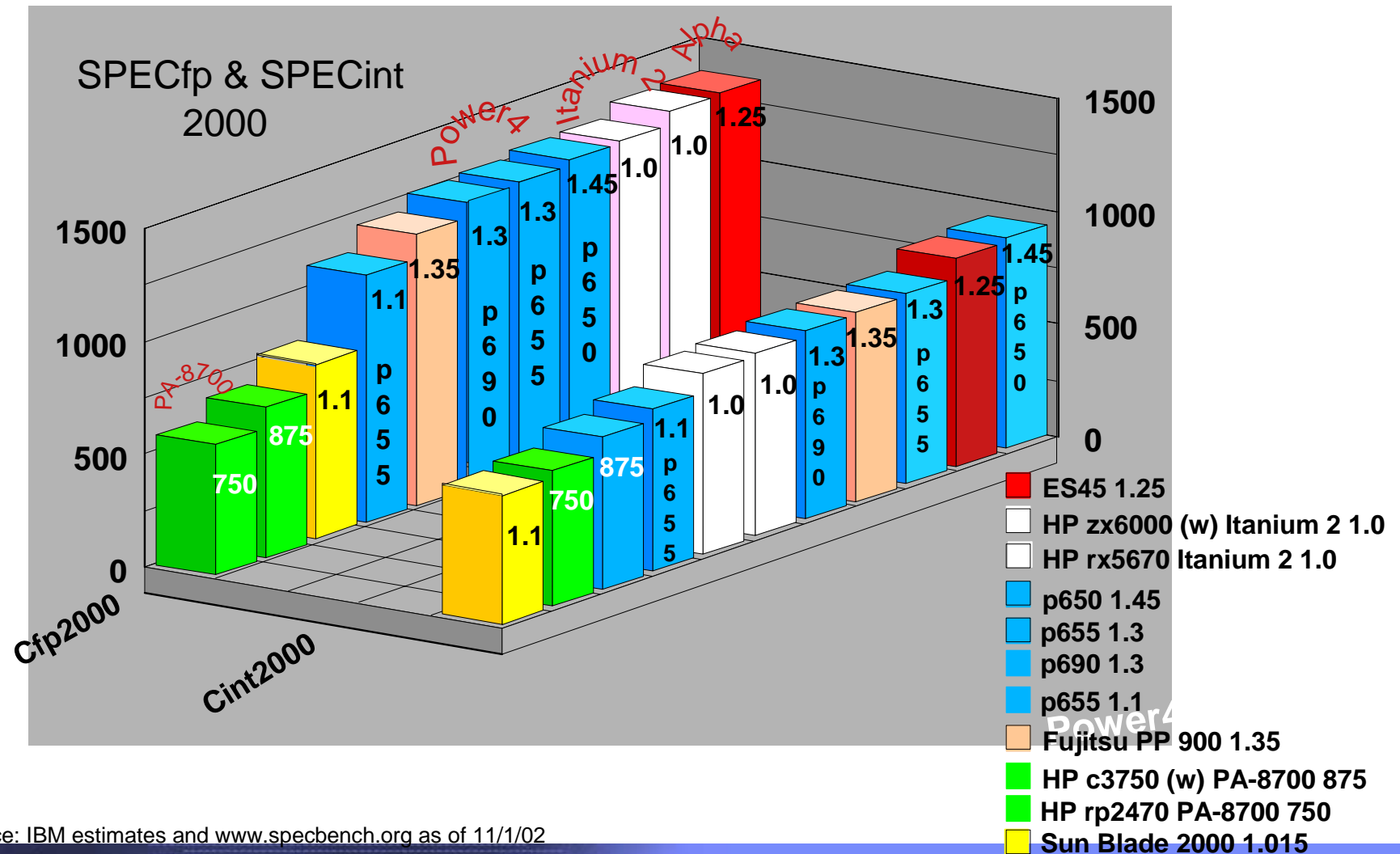
IDC #28257, 11/02. Table 7

Itanium 2's Performance Raised Customer Interest



This is what the environment was looking like last year that sparked customer interest:

IBM leads in SPECint2000 performance and is in a statistical dead heat with Itanium 2 and Alpha on SPECfp2000.



Source: IBM estimates and www.specbench.org as of 11/1/02

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What HP Says that Itanium 2 Offers the Customer

- Greater performance
- Lower price, therefore better price/performance
 - HP promises commodity pricing for enterprise servers based on commodity chip volumes
- Simpler IT environment:
 - Addresses desire of IS organizations to reduce the large # of fragmented platform and UNIX variants will favor deployment of IPF rather than RISC
 - With Itanium - one hardware architecture and five operating systems
 - HP-UX
 - Linux
 - Windows - "emergence of Windows as a data center OS standard for Intel will make IPF decisions more compelling" Gartner 11/28/01)
 - NonStopKernel OS
 - OpenVMS

HP Madison Announcement

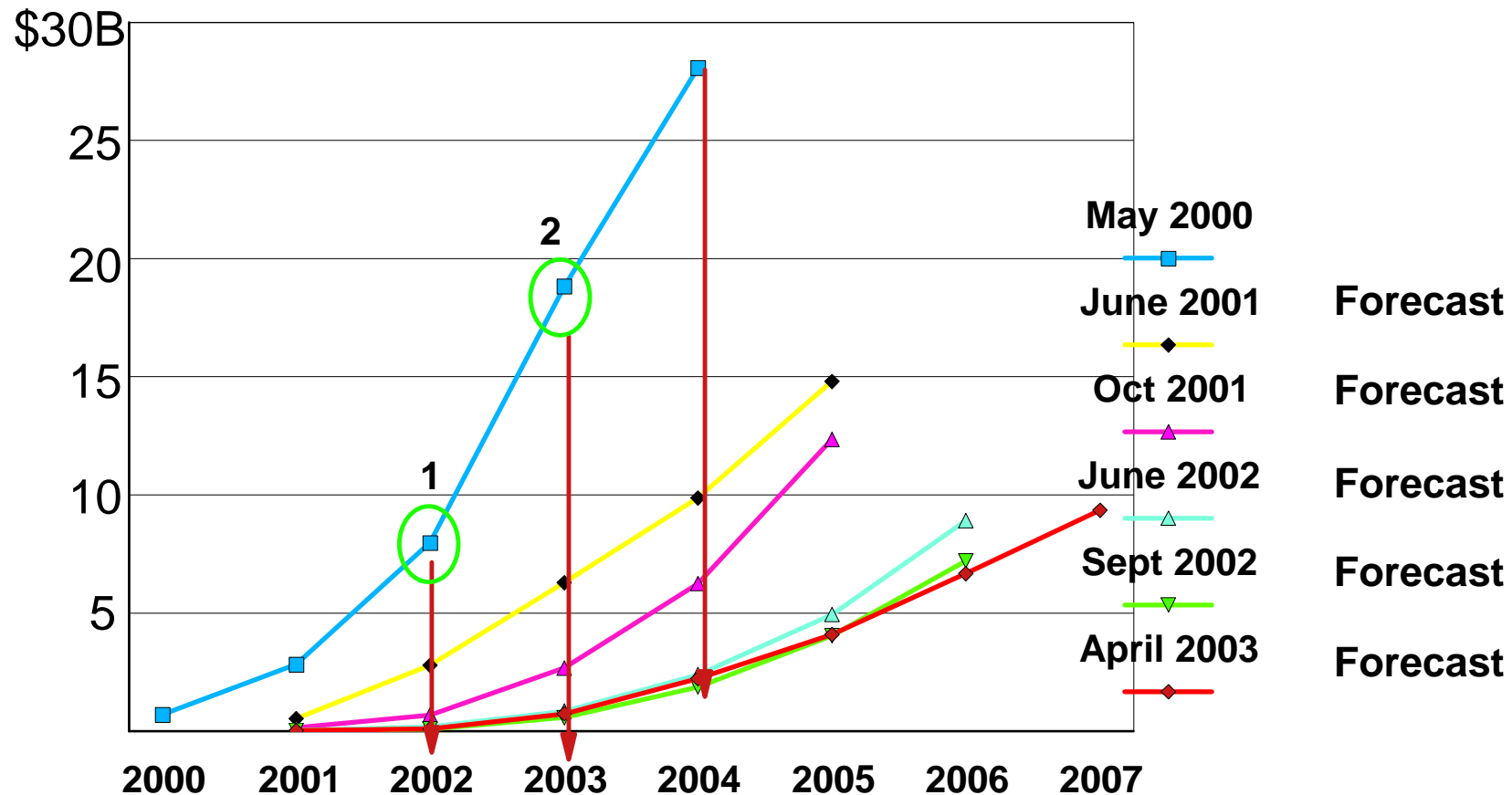
- When: June 30th, 2003
- What: New Madison Itanium 2 chip in various servers
 - rx2600 2-way
 - rx5670 4-way
 - Superdome
 - (to be available 3Q 03 per TPC-C report)
 - Other servers

The Truth About Itanium

Itanium Projections vs Reality



IDC revenue forecasts for Itanium have slipped significantly from initial estimates in 2000 indicating promise of "commodity pricing" may not happen



1. Original projections for 2002 = ~\$7,980 B Actual = \$102M (98.7% less)

2. Original projections for 2003 = \$18,832 B Actual = \$35M (99% less)

Actual 1Q03 = \$35M out of total of total server revenue for 1Q of ~\$10.5B

Source: IDC Tracker 2000, 2001, 2002, 2003

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The Competitive Environment and Intel's Backup Plan?

- What is IA-32 with 64-bit extensions, now called x86-64 or AMD-64
 - ▶ IA-32 enhancement that provides greater performance with additional RAM
 - ▶ Binary compatible with IA-32
 - ▶ Requires only a recompile to obtain performance benefits - not a rewrite
 - ▶ Provides immediate performance enhancements for ISVs with minimum effort
 - ▶ IA-32 bit chip speed improvements + 64-bit extensions provides competitive option
 - ▶ AMD's version is called Opteron; Intel's "secret" version is called Yamhill

Rewrite effort

IA-32 to IA-32 with 64 bit extensions - shorter

IA-32IA-64 (Itanium) - much longer

Gartner states that outside of HPC, IPF will not gain much traction, so let's look at HPC.

Attraction for High Performance Computing

Itanium 2 performance can be a strong attraction for HPC customers because

- performance is a top buying criteria
 - Itanium 2 has good floating point performance
- many have their own code - not reliant on ISVs
 - often require benchmark of actual code to establish application performance
- they have technical skills to optimize applications for new (chip) technology
- they are the early adopters of technology - "bleeding edge"

"Innovators: Venturesome experimentalists who are willing to try out almost any new idea to see what it can do. They amount to about 2 or 3 percent of the total population. E. Rogers



HPC Buying Criteria

HPC Customers Three Major Buying Criteria

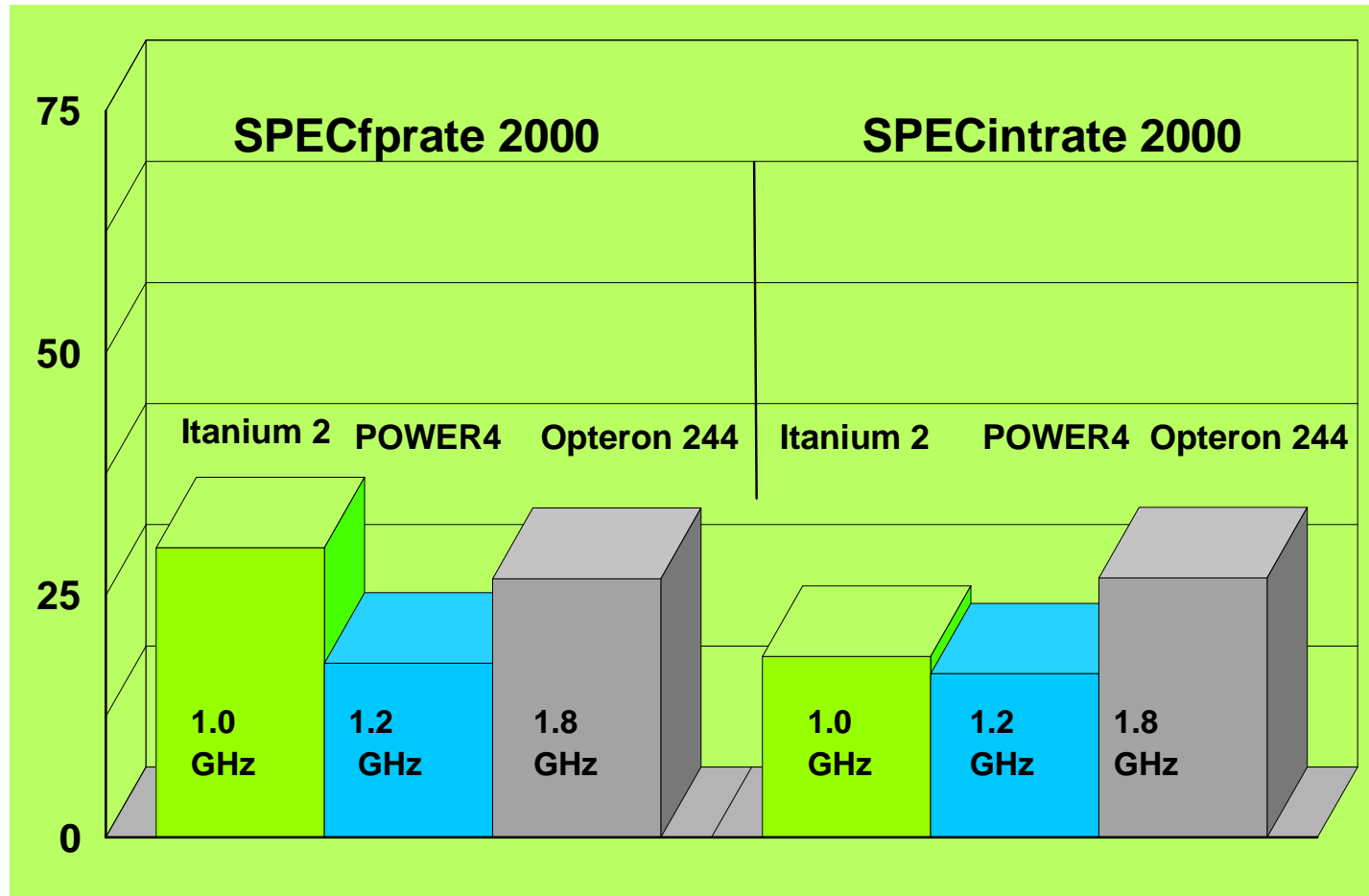
- performance is a top buying criteria
 - Itanium 2 has good floating point performance
- price
 - many Gov/Academic customers buy through bid process
 - Linux popular here
- price/performance
 - price/performance can help you win if you are within a certain performance target

Performance

The Truth About 2-way Performance



The IBM p615 1.2 GHz POWER4 competes against the rx2600 on SPECintrate but loses on SPECfprate; Opteron is tops among these 2-way servers on both SPECfprate and SPECintrate.



Source: www.specbench.org as of 6/17/03

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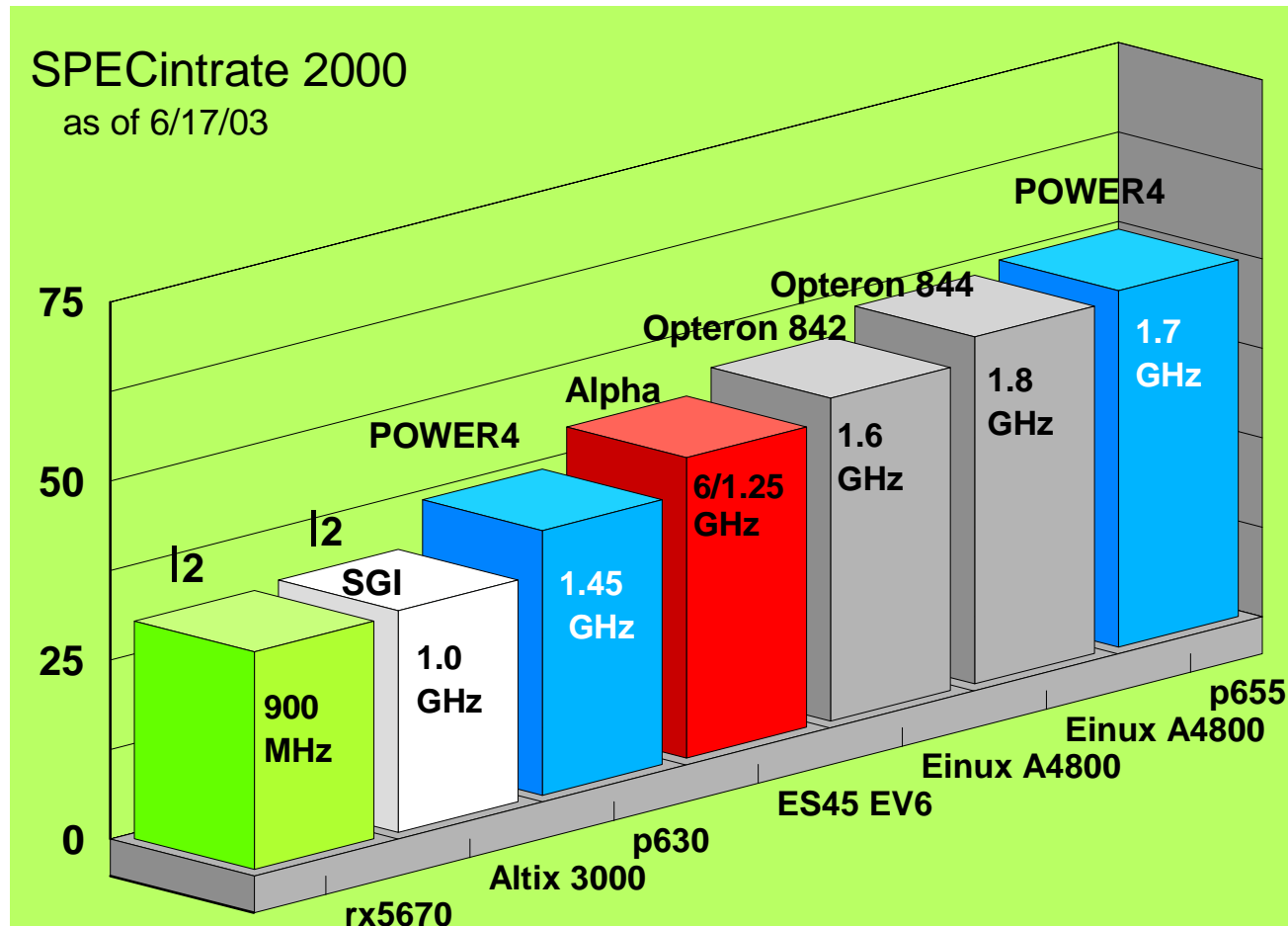
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The Truth About 4-Way Integer Performance



The IBM p655 1.3 POWER4 provides leading SPECintrate performance for 4-way servers and outperforms the rx5670 Itanium 2 server by 63%



Observations

- AMD's Opteron 844 and 842 outperform the 1.0 GHz Itanium 2 in the Altix 3000 server
- Itanium slips in performance ranking of 4-way comparisons

Source: www.specbench.org as of 6/17/03

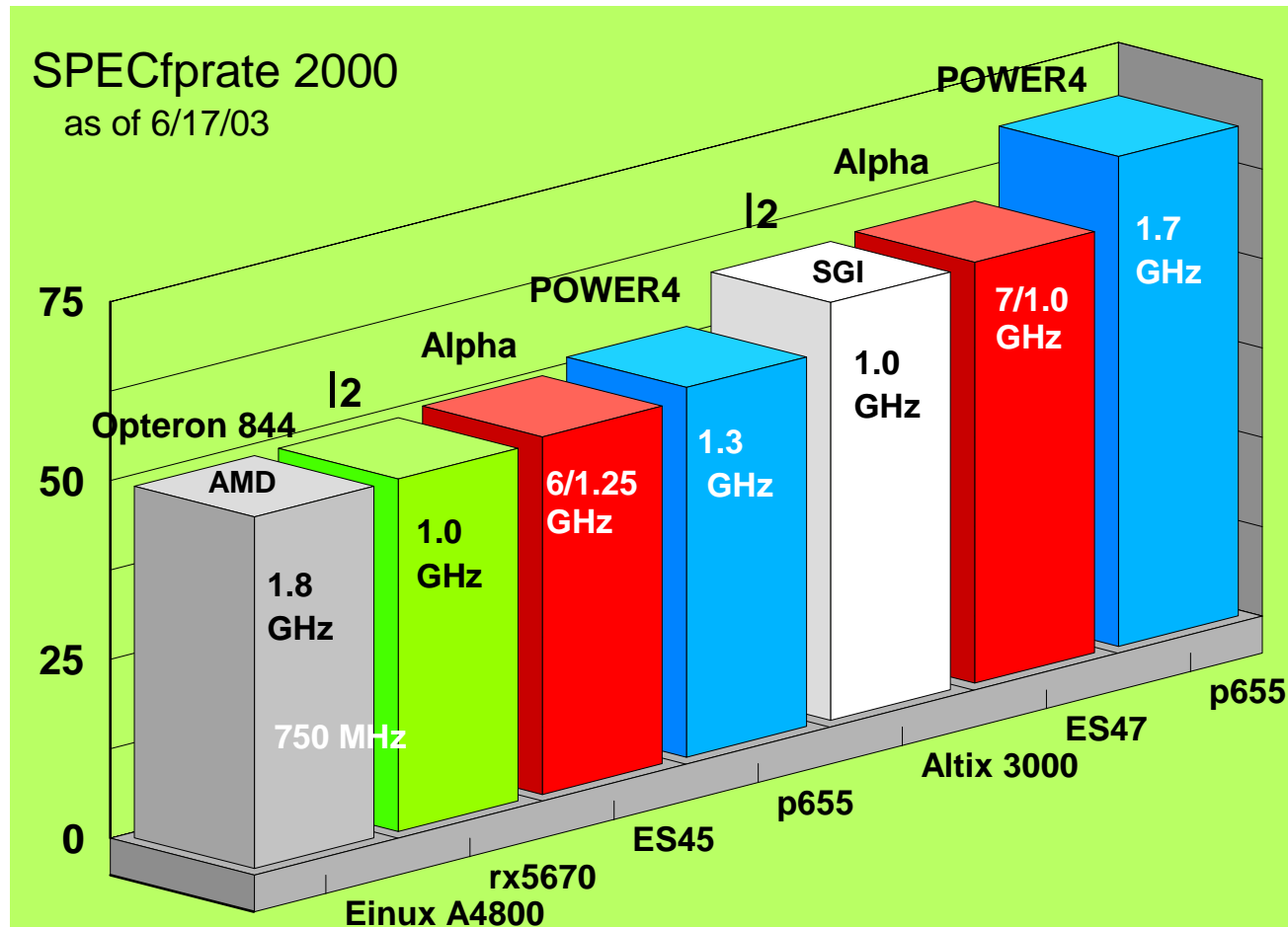
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The Truth About 4-Way Floating Point Performance

The IBM p655 1.3 POWER4 provides leading SPECfprate performance for 4-way servers and outperforms the rx5670 Itanium 2 server by 39%



Observations

- AMD's Opteron 844 is nearly identical in performance to the 1.0 Itanium 2 rx5670
- SGI's 4-way that can grow to 64-way with Itanium has less performance than HP's 4-way rx5670

Source: www.specbench.org as of 6/17/03

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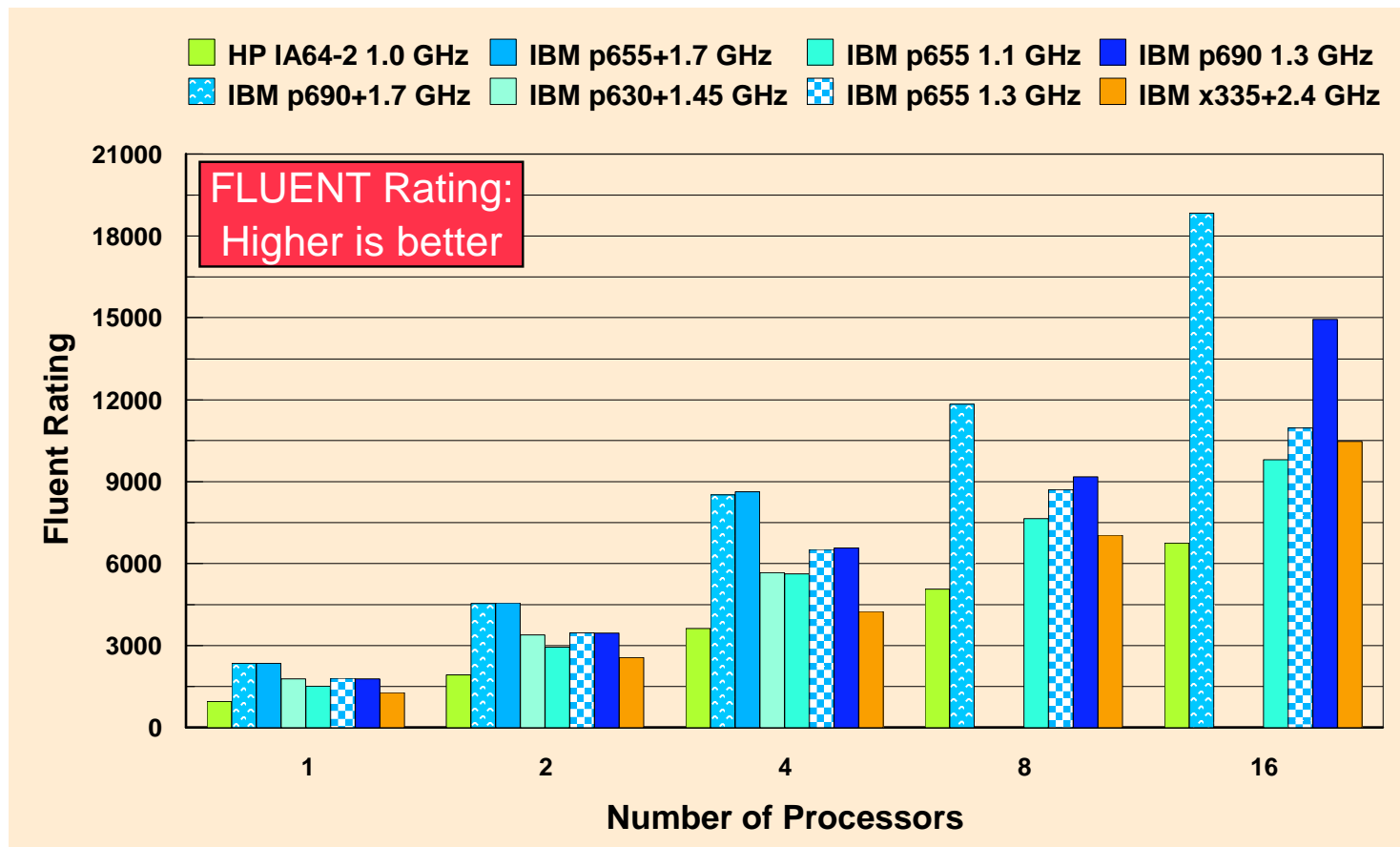
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Fluent 6.1

FL5S2: 32,000 hexahedral cells:

Turbulent flow in a bend, coupled implicit solver

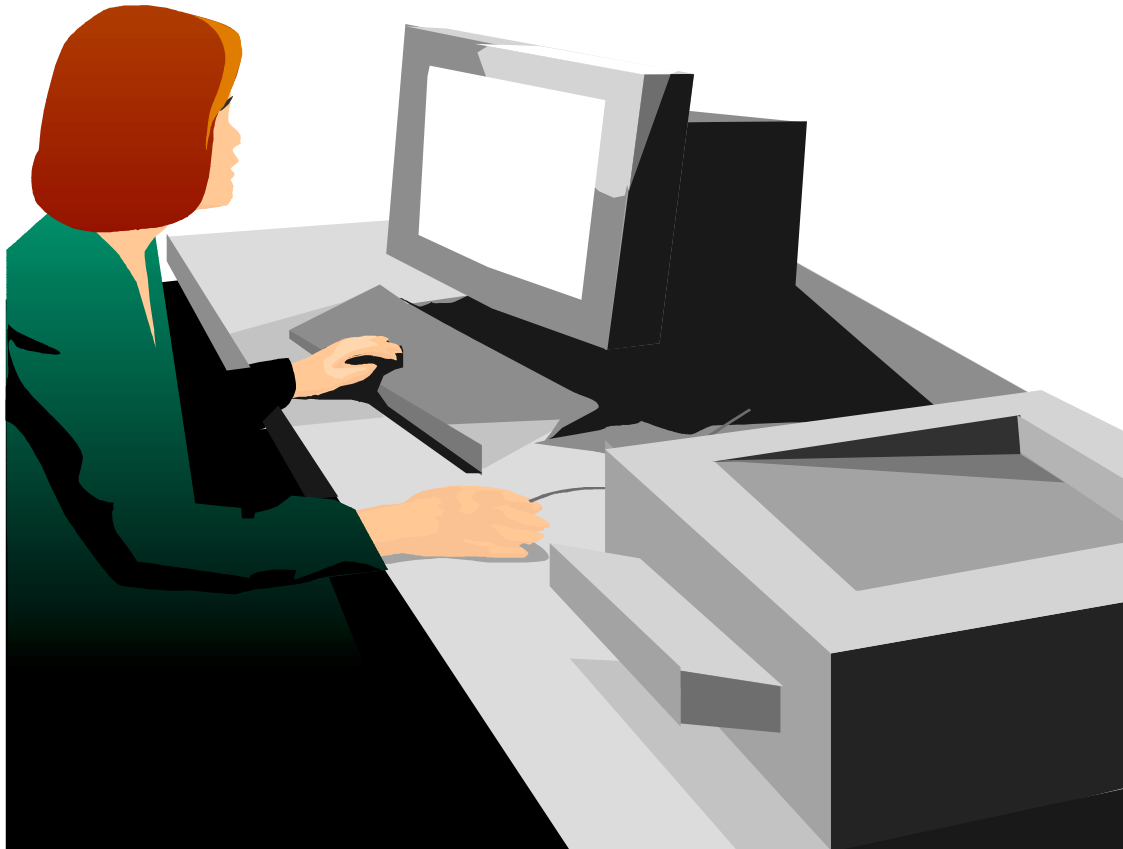
Measure is FLUENT Rating: Higher values are better



- Fluent 6.1 data for all IBM platforms submitted to Fluent 5/8/2003. Other data current as of 5/8/2003
- Source: <http://www.fluent.com/software/fluent/fl5bench/fullres.htm>

Price and Price/Performance

This page under construction ... available
after the Madison announcement



The Truth about Power Requirements



What happens when HP announces the 1.5 GHz Madison?

Row	Description	HP rx2600	HP rx5670	IBM p655
1	Processor	1.0 GHz Itanium 2	1.0 GHz Itanium 2	1.5 / 1.7 GHz POWER4
2	Specfprate 2000	29.90 (2-way)	43.7 (4-way)	92.80 (8) / 68.50 (4)
3	# of processors/server	2	4	8 / 4
4	# of servers/rack	16 (33 EIA rack)	5	16
5	#of servers compared	16	16	16
6	Total # of Processors	32 per rack	20 per rack	128 / 64 per rack
7	Max power / server (Watts)	1,350 ¹	2,089 ¹	1989 ¹
8	Max power / 16 servers (Watts)	21,600	33,424	31,330
9	Max heat dissipation / server (BTUs/hr)	4,375 ¹	7,135 ¹	6,375 ¹
10	Max heat dissipation / 16 servers (BTUs/hr))	70,000 (1 rack)	114,160 (3.2 racks)	102,000 (1 rack)
11	1 year power costs (rded to 100)	\$15,200	\$23,500	\$22,000
12	1 year cooling costs (rded to 100)	\$6,200	\$10,000	\$9,000
13	Total 3 year heating/cooling costs	\$64,200	\$100,500	\$93,000
14	\$/processor (rded to 10)	\$2,010	\$1,570	\$730 / \$1460

1.All IBM numbers are based on full rack and include the rack power distribution unit (PDU); HP numbers based on single servers

Source: Power/cooling for 24x7 operation, 365 days/yr at \$0.08/KWH; environmentals from Ideas International at

w3-3.ibm.com/sales/competition/compdlib.nsf/pages/third+party+tools?Opendocument and vendor Web sites as of 6/13/03

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Lessons from Recent Wins/Losses vs Itanium in HPC Space

- Reports from those who have gone through benchmarks
 - ▶ IBM performs as well as or better against Itanium 2 in some benchmarks and loses in others
 - ▶ SGI is still a tough competitor
- Where we have won
 - ▶ With the p650 and p630
 - ▶ In very large situations
 - ▶ Versus the HP rx5670
 - ▶ Against SGI in some instances
- Where we have had a tough time winning
 - ▶ Where MSC is the business partner with HP
 - ▶ Versus the inexpensive HP rx2600
 - ▶ With the p655 prior to recent price reductions
 - ▶ Against SGI 's Itanium offering in some instances
- Recommendations
 - ▶ Keep selling the basics: IBM, IBM's product excellence, IBM's total solution, IBM's future roadmap
 - ▶ Keep plugging against the SGI installed base, our competitors are
 - ▶ Sell pSeries value proposition of price/performance
 - ▶ With HP, sell higher with the advantages our p650/p655 servers offer and use the recent p655 price reductions and p650 Express Configurations where possible for pricing advantage;
 - ▶ When competing against the rx2600, point out its high power cost/CPU for the rx2600 vs POWER4 (chart included in this presentation)

xSeries in the Itanium Space

- 2-way and 4-way server offerings*
 - ▶ targeted for summer of 03
 - ▶ targeted at the rx2600 and rx5670 space
 - ▶ Linux and Windows 2003 support planned
 - ▶ part of IBM's Cluster 1350 strategy

- 2-way to 16-way offering*
 - ▶ targeted for 2H03
 - ▶ targeted at the rx5670 space
 - ▶ Linux and Windows 2003 support planned
 - ▶ part of IBM's Cluster 1350 strategy

*This information represents IBM's current intentions, goals and objectives, and is subject to change or withdrawal without additional or prior notice.

Let's look at the Commercial Customers

Why Commercial Customers Are Curious About Itanium 2

- Intel's Itanium 2 processor addressed key weakness of Merced design (poor performance)
 - ▶ McKinley addressed poor performance of Merced such that Itanium 2 shows leadership performance on some benchmarks
 - ▶ Up-coming Madison announcement in June with benchmarks already published
- Customers expect Intel processors to be cheaper than RISC alternatives
- HP promising a simpler computing environment
 - ▶ Superdome will be capable of running HP-UX, Linux and Windows on same server

Itanium 2 State of the Union

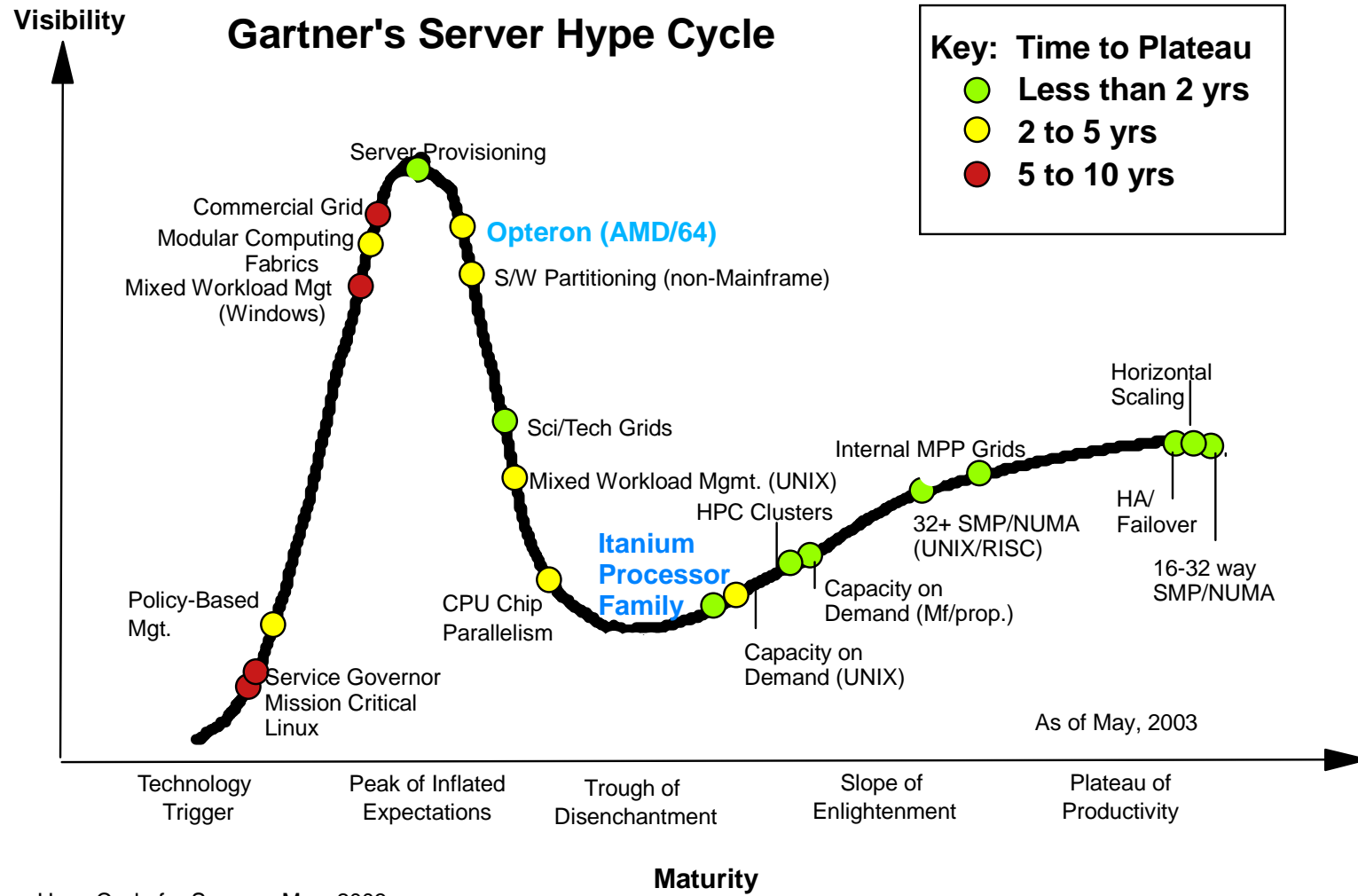


It is IBM's job to point out to customers that while the promise of costs and performance may look good, they can't forget that the ecosystem of applications, middleware, tools, etc. is still in the early stages and is still only being used by a select group of commercial customers

- Itanium 2 is a credible technology
 - ▶ Benchmarks confirm Itanium 1 performance issues corrected
 - ▶ Analysts are split on when Itanium 2 will become mainstream (Gartner reporting 2-5 years from now in Server Hype 2003, 5/03)
 - ▶ Customers are expressing interest in moving some workloads to Itanium 2
- Itanium 2 is a good solution for optimized workloads
 - ▶ Initial beachhead will be in high performance computing and database applications
 - ▶ Driven by floating point performance and larger memory data sets
 - ▶ End to end solution will follow for BI when complete ecosystem is ready



According to Gartner, AMD's Opteron and IPF are both 2-5 years from reaching "Plateau of Productivity"...but IPF is ~ 10 years in the making with billions invested!



Source: Gartner Hype Cycle for Servers, May, 2003

Characteristics of A Mature Server Ecosystem

- ✓ System throughput - not just chip performance
- ✓ Complete Software Environment
 - Operating Systems
 - Databases
 - Middleware
 - Applications
- ✓ Proven Ability
 - Reliability
 - Availability
 - Scalability
 - Manageability

The Truth About Itanium ISVs & Solutions



■ ISV Development Challenges: **Infrastructure not Ready**

- ▶ ISVs require tools, compilers, etc. for development
- ▶ EPIC architecture requires time and effort to optimize code
 - Optimizing for IPF requires recompile AND restructuring code for IPF architecture
 - Microsoft spent year optimizing 64-bit SQL Server to equal IA-32 SQL performance
- ▶ Code Bloat
 - IPF code on average 60% larger than IA-32



■ Solution Deployment: **Ecosystem Immature**

- ▶ Limited application base
 - 100 - 300+ possible apps on three operating systems (HP-UX, Linux, Windows) vs. 100,000's; HP-UX alone has 16,000+
 - Focus on 64-bit addressing and floating point applications
- ▶ Migration Path - must migrate or run in degraded mode
 - IPF supports IA-32 binaries running at 1.5 Xeon of native performance (current fastest Xeon chips are at 3.06 GHz)
 - PA-RISC compatibility also shows degradation; 'Aries' environment runs at 60-90% of native performance



The Truth about "Best Customer Experience" IBM

HP's states they are focused on the "Best Customer Experience," but is this what HP considers "Best Customer Experience? ...

Peter Blakemore, head of HP's ESG, is quoted at the recent (6/3/03) analyst conference as saying:

- Regarding the slow effort of ISVs to port applications to Itanium, Blackmore said, "**Don't worry about ISVs...**Worry about our competitors who remain on RISC....Itanium will be the standard."
- Regarding the move to Itanium, ESG head Peter Blackmore said, "**We'll put Alpha and PA-RISC into maintenance mode in 2004.**"

Migration or Emulation

- Customers are told that emulation packages are available to minimize the impact and effort of the migration
- Emulations packages provide degraded performance
 - ▶ IA-32 emulation planned for Windows and Linux at about the performance of 1.5 GHz Xeon*
- Migration involves rewriting to the EPIC architecture of IPF
 - ▶ Requires S/W and applications be optimized to obtain maximum performance benefits
 - ▶ Aries for HP-UX at 60% native performance for some applications
- However, a mature ecosystem is available today for IA-32 and POWER processor based systems
 - ▶ IA-32; Linux and Windows based application and tools available and mature
 - ▶ Power; AIX based applications, middleware, and tools are available today and optimized

Intel Re-thinks 32-bit, Yahoo News, 5/03

"Aries is a binary emulator that transparently emulates 32-bit and 64-bit HP-UX/PA applications on HP-UX/IPF Servers" but
HP now recommends all applications be recompiled with few exceptions

- ✓ Aries does not¹:
 - support emulation of debuggers
 - support emulation of privileged PA instructions
 - support HP-UX/IPF applications that try to use HP-UX/PA shared libraries (or vice-versa)
 - guarantee correct operation of timing-dependent applications
 - these may fail under Aries
- ✓ Aries does:
 - cause integer applications to slow down by a factor of 2-4¹
 - cause floating-point applications to slow down by a factor of 3-6¹
 - cause Oracle 8i with Aries/PA on IPF to perform at 60% of native IPF performance²

Sources: ¹ "Compatibility Mode on HP-UX/IPF: A Developer Perspective", <http://devresource.hp.com/STK/Aries.html>, 7/16/02
² HP Technology Forum, June 12, 2001

As HP-UX customers are expected to move to IPF they find themselves facing many unknowns

- ✓ Whose business requirements drive processor plans? Intel's or HP's or Microsoft's?
 - Itanium processors are Intel controlled and represent a major architectural change requiring customers to make hardware, software, data changes
 - HP telling customers follow on to HP-8900 may be required because IPF not addressing high-end server requirements
- ✓ Will HP be able to implement all the roadmap changes as promised and on schedule?
 - evidently not: HP just announced that the converged version of HP-UX
 - that will run on PA-RISC and Itanium will not be ready this summer as previously indicated, but rather 18 months later in late 2004.
- ✓ Will ISVs move applications over to IPF? When?
 - only 100-300 applications available across all three OSes (HP-UX, Windows, Linux)

Superdome and p690 playing leapfrog on TPC-C

	OS	OLTP Perf	Server Config	Date of Report
p690	AIX	427,760 tpmC at \$17.756/tpmC Available: 5/31/2003	32-way 1.3 GHz POWER4 512 GB RAM	December 26, 2002
SD	Microsoft Windows 2003	658,277 tpmC at 9.80/tpmC Available: 10/23/2003	64-way 1.5 GHZ Itanium 2 512 GB RAM	April 24, 2003
p690	AIX	680,613 tpmC at \$11.13/tpmC Available: 11/8/2003	32-way 1.7 GHZ POWER4 512 GB RAM	May, 9, 2003
SD	Microsoft Windows 2003	707,102 tpmC at \$9.13/tpmC Available: 10/23/2003	64-way 1.5 GHZ Itanium 2 512 GB RAM	May 16, 2003



Performance leapfrog

Source: TPC-C data from www.tpc.org June 17, 2003

Upgrading Superdome to Itanium

- HP says: just swap out cell board and processors for upgrade, but
- Customers will have to migrate to and run ...
 - a new version of their OS
 - a new version of their application code (unless running in degraded mode)
 - Aries emulator for HP-UX
 - IA-32 emulator for Windows and Linux
 - a new version of their middleware, including databases
 - a new processor chip set
 - a new i/o chip set

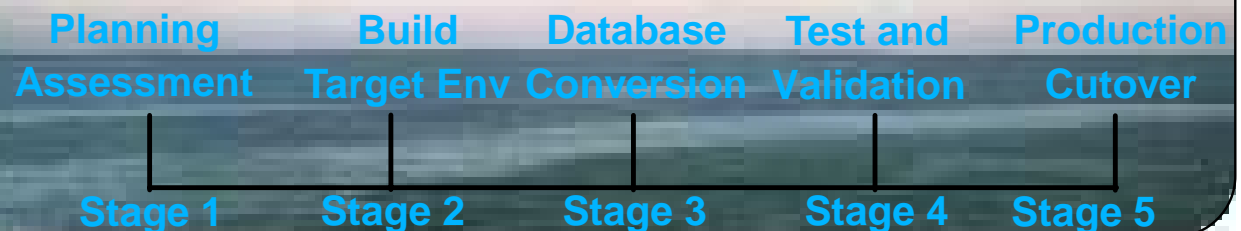
Migrating HP-UX to AIX on POWER vs Itanium

Issues involved in switching platforms	HP to IBM: Moving from HP-UX on PA-RISC to AIX on pSeries	HP to HP: Moving from HP-UX on PA-RISC to HP-UX on Itanium
Will HP-UX/PA-RISC applications run on the new platform without recompiling?	No	Yes, but <u>only</u> if you use Aries emulator. But Aries is only recommended by HP under 2 conditions (per HP World, 2002) 1. no choice (source code not available) 2. performance doesn't matter
New OS	Yes	Yes; HP field engineers report that HP-UX on Itanium is a different OS to install and get up and running; requires retraining of HP personnel and will be another variable in HP problem determination
New hardware	Yes	Yes , all cellboards and all processors replaced on PA-RISC cell-based servers
Applications and other software available on new platform?	Thousands of ISV apps already available	Little software currently available on the new platform
Database migration	Yes, and all databases are proven and available on pSeries today	Yes; new version of Oracle now available for customers to try
Data conversion	AIX and HP-UX are both big endian meaning there is no required data conversion going to AIX	Itanium is bi-endian, meaning there is no required data conversion from big endian to little endian but HP-UX remains big endian and Microsoft is little endian; customers running both OSes on same server must deal with different ways that data is handled/stored
Retraining issues for personnel	Yes, but it is UNIX to UNIX and AIX is easy to use with SMITTY interface	Must learn the differences between HP-UX on PA-RISC vs. on IPF such as installation; some learning required
Choosing a partner to help	IBM has in-depth experience, skills, and resources for a safe migration	HP does not have the in-depth experience and skills that IBM has

IBM Minimizes the Risk for Customers Facing Migrations

For a smooth move, call

- ▶ IBM offers a stable target platform environment to move to vs. a new emerging technology
- ▶ IBM has a proven track record of reliability and availability with POWER vs. unknown availability of a whole new environment that has not yet been integrated and proven
- ▶ POWER has proven track record of scalability vs. unknown and unproven scalability of IPF
- ▶ IBM p690 provides cost justification with software costs because of 2:1 OLTP processor performance
- ▶ IBM's POWER roadmap (which already shows POWER4, POWER4+, POWER5, and POWER6) provides customers with a solid, stable, powerful future in UNIX and Linux computing
- ▶ IBM offers many attractive financial options through IGF
- ▶ IBM has a proven track record in negotiating customers through platform switches while meeting project deadlines
- ▶ IBM has proven process for customers who need to re-platform

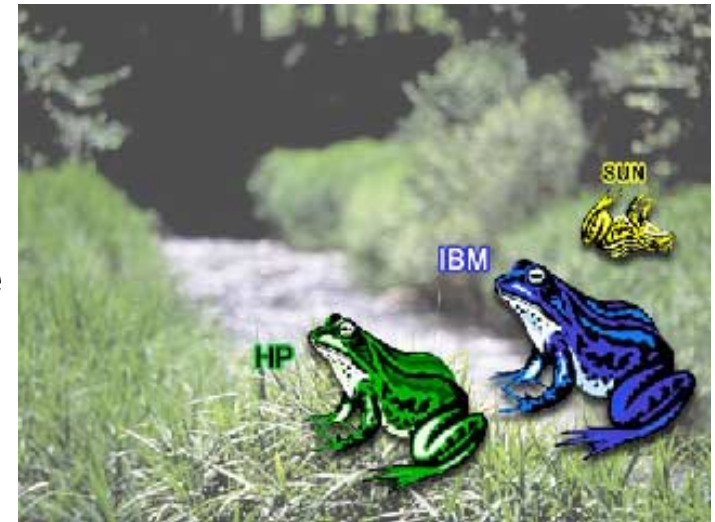


■ The HP Promise of Itanium

- ▶ Higher performance
- ▶ Commodity pricing for servers due to lower chip costs
- ▶ Easier computing environment with multiple OSes on one platform
- ▶ Don't need to migrate HP-UX applications, can run Aries emulator

■ The truth about HP and the Itanium promise

- ▶ POWER and Itanium leapfrogging each other in performance
- ▶ SD Itanium server costs = SD PA-RISC costs per 5/20/03 TPC-C report
- ▶ Without volumes, there are no lower chip costs (see next page)
- ▶ Digital tried multiple operating systems (UNIX, Windows, OpenVMS) on Alpha and we know what happened with that
- ▶ Political / organizational impact of mixing Windows / UNIX on same server
- ▶ HP stated at HP World 2002 only to use Aries if you didn't have source code or performance didn't matter
- ▶ Microsoft and Linux emulation performance expected to approximate performance of Xeon 1.5 GHz*



Performance leapfrog

■ The Ecosystem for Itanium

- ▶ Traction in High Performance Computing
- ▶ Commercial ecosystem not yet in place - only about 100 to 200 applications

■ Competition

- ▶ AMD's Opteron chip is x86-64 (IA-32 bit with 64-bit extensions)
- ▶ Requires only a recompile to obtain performance improvements due to larger memory
- ▶ Much easier for ISVs to convert applications vs EPIC architecture of Itanium
- ▶ Opteron sales potentially have a negative impact of Itanium manufacturing volumes
- ▶ Lower volumes mean higher manufacturing costs and higher prices

*Yahoo News: Intel Rethinks 32-bit Support in Itanium, 4/24/03

Migrating to AIX/pSeries is a Better Decision than taking the risk of HP's Itanium Product Family!

1. Very few customers have moved to Itanium 2 so far - and is 2-5 Years away from mainstream productivity, per Gartner Group
2. Most code migration will require recompiling, restructuring, and/or significant tuning
3. Ecosystem is immature, as few ISV Applications are available on Itanium
4. Must use Aries Emulator to run 32-bit applications, at 2-6x performance degradation versus current PA-RISC or Intel systems
5. Running multiple OS on Itanium (HP-UX, Linux, Windows) sounds great, but is filled with challenges including manageability, performance, data formats, etc.
6. HP and Intel continue to miss delivery promises, despite a decade of Itanium development.

**"We believe HP's bet on Itanium
is growing riskier by the day..."**

Itanium Doubts - Trouble for HP? by
Gabrielle Consulting Group, 1/16/03

IBM Marketing Collateral Plan for HP's Madison Announcement

Field Deliverables	When	Format	Content	Where to Find
Alert to the field	Day of announce	Lotus Note	Overview of the announcement	COMP
Alert to the field	Announce + 2 days	Lotus Note	Initial analysis of the announcement	COMP
Silver bullets call	Announce + 8 days	Presentation for IBM sales force & BP education given in one hour teleconference	Pricing and performance positioning of pSeries vs HP Madison servers	Call info on Systems Sales site; presentation also in HP Compete Pak
pSeries Competitive Landscape documents	Following	Presentations for IBM sales force & BP education	Competitive Landscapes compare pSeries servers vs HP and Sun; will be updated to reflect HP's announcement	Presentations posted on Systems Sales site, in the HP and Sun Compete Paks, and in COMP

Whitepapers will be posted to the Server Sales Site and in the HP Compete Pak as they become available

***Analyst paper: Itanium Doubts - Trouble for HP? just posted**

***IBM white paper on POWER architecture coming to Systems Sales site in 2-3 weeks**

COMP: <http://w3-3.ibm.com/sales/competition/compdlib.nsf/pages/comp>

Systems Sales Site: <http://w3-1.ibm.com/sales/systems/ibmsm.nsf>

HP Compete Pak (section: Response to Madison Annncement:

IBM ^

Analyst comments on IPF and the IPF ecosystem:

- "IPF will likely not gain a substantial market share until at least late 2003, primarily because of the availability of commercial software. Enterprises should wait until all three elements (Hardware, OS and Applications) align before considering production deployment of Itanium 2 solutions.

Gartner: "Consider Itanium 2 Only When Three Elements Fall into Place, July 9, 2002

- "The new microprocessor has arrived, but the ecosystem that will allow it to 'take off' is still being put into place."

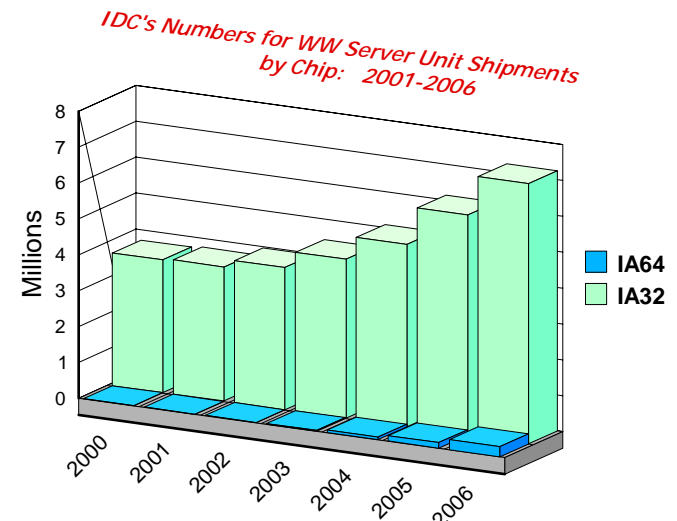
IDC: Intel Revs up Itanium 2 Microprocessor for Volume Deployments, July, 2002

- "It is important to remember that IA32 Pentium and Xeon server shipments are expected to continue as a strong element of the overall worldwide server market.."

IDC: Intel Revs up Itanium 2 Microprocessor for Volume Deployments, July, 2002

- "Intel Architecture 32-bit (IA-32) computing will continue to thrive as a mainstream technology through Gartner's five-year planning horizon (to 2006)... ." "Enterprises can consider a transition from IA-32 to IPF computing when sufficient proof of application availability, application performance and application stability is available"

Gartner: The Future of IA-32 Computing, Nov., 2001



Source: IDC, WW Server Market Forecast, Update, 2001-2006; IDC #28257, 11/02 (Table 7)

Backup Plans for Itanium's Failure from NY Times

9/29/02:

- **"It has taken an entire decade, an estimated \$5 billion and teams of hundreds of engineers from the two companies to bring the first Itanium chip to market. As the struggles and costs mount for the companies, skeptical technologists say Itanium has the hallmarks of a bloated project in deep trouble."**
NY Times: "Intel's Huge Bet Turns Iffy", Sept. 29, 2002
- **"Increasingly, Intel is facing the risk that it has chosen the wrong path to high-performance computing."**
NY Times: "Intel's Huge Bet Turns Iffy", Sept. 29, 2002
- **Intel rival, "Advanced Micro Devices, has an alternative to Itanium that computer makers are seriously considering. And Intel has a fallback project, called Yamhill, in case Itanium founders."**
NY Times: "Intel's Huge Bet Turns Iffy", Sept. 29, 2002
- **"Opteron {AMD's chip}, which will begin shipping next year, is based on the original Intel-designed X86 instruction set. That means the chip will run all existing software intended for other Intel chips, as well as compatible processors, with only minor alterations."**
NY Times: "Intel's Huge Bet Turns Iffy", Sept. 29, 2002
- **"If Itanium fails, Hewlett-Packard will be forced to go with Yamhill or AMD... ."**
Steven M. Milunovich, Merrill Lynch analyst, quoted in NY Times: "Intel's Huge Bet Turns Iffy", Sept. 29, 2002

Backup

- HPC Application Benchmark Charts
 - ▶ Fluent
 - ▶ LS-DYNA
 - ▶ STAR-CD
- Current as of May, 2003

Notes to Presenter

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Notes on Benchmarks and Values

The benchmarks and values shown herein were derived using particular, well configured, development-level computer systems. Unless otherwise indicated for a system, the values were derived using external cache, if external cache is supported on the system. Buyers should consult other sources of information to evaluate the performance of systems they are considering buying and should consider conducting application oriented testing. For additional information about the benchmarks, values and systems tested, contact your local IBM office or IBM authorized reseller or access the following on the Web:

TPC	http://www.tpc.org	Linpack	http://www.netlib.org/benchmark/performance.p
Pro/E	http://www.proe.com	SPEC	http://www.spec.org
GPC	http://www.spec.org/gpc	NotesBench Mail	http://www.notesbench.org
VolanoMark	http://www.volano.com	STREAM	http://www.cs.virginia.edu/stream/
ANSYS	http://www.ansys.com/services/hardware_support/57Benchmarks.htm		
FLUENT	http://www.fluent.com/software/fluent/fl5bench	CHARMm	http://www.accelrys.com
LS-DYNA	http://www.wpi.edu/Academics/Depts/CEE/Roadsafe/bench.html	Gaussian	http://www.gaussian.com
AMBER	http://www.amber.ucsf.edu/amber/amber.html		

Unless otherwise indicated for a system, the performance benchmarks were conducted using AIX V4.3 or AIX 5L. IBM C Set++ for AIX and IBM XL FORTRAN for AIX with optimization were the compilers used in the benchmark tests. The preprocessors used in some benchmark tests include KAP 3.2 for FORTRAN and KAP/C 1.4.2 from Kuck & Associates and VAST-2 v4.01X8 from Pacific-Sierra Research. The preprocessors were purchased separately from these vendors. Other software packages like IBM ESSL for AIX and MASS for AIX were also used in some benchmarks.

The following SPEC and Linpack benchmarks reflect microprocessor, memory architecture, and compiler performance of the tested system (XX is either 95 or 2000):

- SPECintXX - SPEC component-level benchmark that measures integer performance. Result is the geometric mean of eight tests comprising the CINTXX benchmark suite. All of these are written in the C language. SPECint_baseXX is the result of the same tests as CINTXX with a maximum of four compiler flags that must be used in all eight tests.
- SPECint_rateXX - Geometric average of the eight SPEC rates from the SPEC integer tests (CINTXX). SPECint_base_rateXX is the result of the same tests as CINTXX with a maximum of four compiler flags that must be used in all eight tests.
- SPECfpXX - SPEC component-level benchmark that measures floating-point performance. Result is the geometric mean of ten tests, all written in FORTRAN, included in the CFPXX benchmark suite. SPECfp_baseXX is the result of the same tests as CFPXX with a maximum of four compiler flags that must be used in all ten tests.
- SPECfp_rateXX - Geometric average of the ten SPEC rates from SPEC floating-point tests (CFPXX). SPECfp_base_rateXX is the result of the same tests as CFPXX with a maximum of four compiler flags that must be used in all ten tests.
- SPECweb96 - Maximum number of Hypertext Transfer Protocol (HTTP) operations per second achieved on the SPECweb96 benchmark without significant degradation of response time. The Web server software is ZEUS v.1.1 from Zeus Technology Ltd.
- SPECweb99 - Number of conforming, simultaneous connections the Web server can support using a predefined workload. The SPECweb99 test harness emulates clients sending the HTTP requests in the workload over slow Internet connections to the Web server. The Web server software is Zeus from Zeus Technology Ltd.
- SPECweb99_SSL - Number of conforming, simultaneous SSL encryption/decryption connections the Web server can support using a predefined workload. The Web server software is Zeus from Zeus Technology Ltd.
- SPEC OMP2001 - Measures performance based on OpenMP applications.
- SPECsfs97_R1 - Measures speed and request-handling capabilities of NFS (network file server) computers.

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Notes on Benchmarks and Values (Cont.)

- SPECjAppServer200X (where X is 1 or 2) - Measures the performance of Java Enterprise Application Servers using a subset of J2EE APIs in a complete end-to-end Web application.

The Linpack benchmark measures floating-point performance of a system.

- Linpack DP (Double Precision) - $n=100$ is the array size. The results are measured in megaflops (MFLOPS).
- Linpack SP (Single Precision) - $n=100$ is the array size. The results are measured in MFLOPS.
- Linpack TPP (Toward Peak Performance) - $n=1,000$ is the array size. The results are measured in MFLOPS.
- Linpack HPC (Highly Parallel Computing) - solves the largest system of linear equations possible. The results are measured in GFLOPS.

STREAM measures sustainable memory bandwidth in high performance computers.

VolanoMark is a 100% pure Java server benchmark that creates long-lasting network client connections in groups of 20 and measures how long it takes for the clients to take turns broadcasting their messages to the group. The benchmark reports a score as the average number of messages transferred by the server per second.

The following Transaction Processing Performance Council (TPC) benchmarks reflect the performance of the microprocessor, memory subsystem, disk subsystem, and some portions of the network:

- tpmC - TPC Benchmark C throughput measured as the average number of transactions processed per minute during a valid TPC-C configuration run of at least twenty minutes.
- \$/tpmC - TPC Benchmark C price/performance ratio reflects the estimated five year total cost of ownership for system hardware, software, and maintenance and is determined by dividing such estimated total cost by the tpmC for the system.
- QppH is the power metric of TPC-H and is based on a geometric mean of the 17 TPC-H queries, the insert test, and the delete test. It measures the ability of the system to give a single user the best possible response time by harnessing all available resources. QppH is scaled based on database size from 30GB to 10TB.
- QthH is the throughput metric of TPC-H and is a classical throughput measurement characterizing the ability of the system to support a multiuser workload in a balanced way. A number of query users is chosen, each of which must execute the full set of 17 queries in a different order. In the background, there is an update stream running a series of insert/delete operations. QthH is scaled based on the database size from 30GB to 10TB.
- \$/QphH is the price/performance metric for the TPC-H benchmark where QphH is the geometric mean of QppH and QthH. The price is the five-year cost of ownership for the tested configuration and includes maintenance and software support.

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Notes on Benchmarks and Values (Cont.)

The following graphics benchmarks reflect the performance of the microprocessor, memory subsystem, and graphics adapter:

- SPECxpc results - Xmark93 is the weighted geometric mean of 447 tests executed in the x11perf suite and is an indicator of 2D graphics performance in an X environment. Larger values indicate better performance.
- SPECplb results (graPHIGS) - PLBwire93 and PLBsurf93 are geometric means of literal and optimized Picture Level Benchmark (PLB) tests for 3D wireframe and 3D surface tests, respectively. Larger values indicate better performance.
- SPECopc results - Viewperf 7 (3dsmax-01, DRV-08, DX-07, Light-05, ProE-01, UGS-01) and Viewperf 6.1.2 (AWadv-04, DRV-07, DX-06, Light-04, medMCAD-01, ProCDRS-03) are weighted geometric means of individual viewset metrics. Larger values indicate better performance.

The following graphics benchmarks reflect the performance of the microprocessor, memory subsystem, graphics adapter and disk subsystem.

- SPECapc Pro/Engineer 2000i2 results - PROE2000I2_2000370 was developed by the SPECapc committee to measure UNIX and Windows workstations in a comparable real-world environment. Larger numbers indicate better performance.

The NotesBench Mail workload simulates users reading and sending mail. A simulated user will execute a prescribed set of functions 4 times per hour and will generate mail traffic about every 90 minutes. Performance metrics are:

- NotesMark - transactions/minute (TPM).
- NotesBench users - number of client (user) sessions being simulated by the NotesBench workload.
- \$/NotesMark - ratio of total system cost divided by the NotesMark (TPM) achieved on the Mail workload.
- \$/User - ratio of total system cost divided by the number of client sessions successfully simulated for the NotesBench Mail workload measured. Total system cost is the price of the server under test to the customer, including hardware, operating system, and Domino Server licenses.

Application Benchmarks

- SAP - Benchmark overview information: www.sap-ag.de/solutions/technology/bench.htm; Benchmark White Paper September, 2000; www.sap-ag.de/solutions/technology/pdf/50020428.pdf
- PeopleSoft - To get information on PeopleSoft benchmarks, contact PeopleSoft directly or the PeopleSoft/IBM International Competency Center in San Mateo, CA.
- Oracle Applications - Benchmark overview information: www.oracle.com/apps_benchmark/
- Baan - The Baan benchmark demonstrates the scalability of Baan ERP solutions. The test results provide the number of Baan Reference Users (BRUs) that can be supported on a specific system. BRU is a single on-line user or a batch unit workload. These metrics are consistent with those used internally by both IBM and Baan to size systems. To get information on Baan benchmarks, contact Baan directly or the IBM/Baan International Competency Center in San Mateo, CA.
- J.D. Edwards Applications - Product overview information at www.jdedwards.com

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Notes on Performance Estimates

rPerf

rPerf (Relative Performance) is an estimate of commercial processing performance derived from an IBM analytical model which uses characteristics from internal workloads, TPC and SPEC benchmarks. rPerf is not intended to represent any specific public benchmark and should not be used in that way. The model simulates some of the system's operations such as CPU, cache, and memory. However, the model does not simulate disk or network I/O operations. Although the model uses general database and operating system parameters, the model does not reflect specific databases or AIX version or releases. Unless otherwise indicated for a system, the model assumes the use of 32-bit applications.

Unless otherwise indicated for a system, rPerf is estimated only at the time the system is introduced. An IBM eServer pSeries 640 B80 is the baseline reference system and has a value of 1.0. Although rPerf may be used to compare estimated IBM UNIX commercial processing performance, actual system performance may vary and is dependent upon many factors including system hardware configuration and software design, operating system release and configuration. All performance estimates are provided "AS IS" and no warranties or guarantees are expressed or implied by IBM. Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of a system they are considering buying. For additional information about rPerf, system performance, and benchmarks, contact your local IBM office or IBM authorized reseller or access the following Web sites:

SPEC	http://www.spec.org	Pro/E	http://www.proe.com
TPC	http://www.tpc.org	GPC	http://www.spec.org/gpc
Linpack	http://www.netlib.no/netlib/benchmark/performance.ps	NotesBench Mail	http://www.notesbench.org
VolanoMark	http://www.volano.com/benchmarks.html		

RQP

Relative Query Performance (RQP) is based on internal measurements and modeling of IBM UNIX systems and may be used to augment other performance and marketing information available in assisting the sizing and selection of systems for data marts, data warehouses, OLAP, and data mining. This helps IBM define its current position in business intelligence and decision support relative to previously announced IBM UNIX systems. RQP is an easy-to-use metric for evaluating a system's ability to process complex queries and data sets commonly found in data marts and entry to midrange data warehouses.

RQP is an estimate of performance in business intelligence applications where complex queries are used for decision support. RQP is intended to position IBM UNIX SMP systems relative to the performance of an IBM RS/6000 Model F50 166 MHz system. As the baseline system, the Model F50 has a RQP value of 1. RQP estimates do not reflect specific databases nor AIX versions or releases. Although RQP may be used to compare estimated system performance in business intelligence applications, actual system performance may vary and is dependent upon many factors including system hardware configuration and software design and configuration. All performance estimates are provided "AS IS" and no warranties or guarantees are expressed or implied by IBM. Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of a system they are considering buying.